Bacterial antibioresistance: its implication in Better Management Practices

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CIRAD

Bacterial antibioresistance: its implication in Better Management Practices

- Resistance to antibiotics
- Bacterial adaptation
- Antibioresistance in catfish (Vietnam)
- Better Management Practices
- Research perspectives

Bacterial antibioresistance: its implication in Better Management Practices

- Collaborators:

  Sarter S., H.N.K.Nguyen[a] , L.T. Hung[a], J.Lazard[b], D.Montet[b] . Antibiotic resistance in Gram-negative bacteria isolated from farmed catfish. Food control 2007, 18, 1391–1396

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Resistance to antibiotics

- One of the major public health problems (WHO)
- International spread of microorganisms
- It is a global problem and requires a common strategy

Resistance to antibiotics

- Difference between antibiotic residues and antibiotic resistance

- Even when treatment is suspended before the fish is sold for consumption, the resistance can still be transmitted

Resistance to antibiotics

- All antimicrobial drugs can select microorganisms that are resistant
- Impact of farming practices extends beyond the individual farm environment

Resistance to antibiotics

- Once acquired, resistance determinants could be maintained within the bacterial population even in the absence of the corresponding antibiotic

Resistance to antibiotics

- Interaction between different ecological systems

- Potential transfer of resistant bacteria or resistant genes from animals to humans may occur through the food chain

Resistance to antibiotics

- Antibiotic-resistant bacteria have been isolated from the carcasses of catfish from the retail market

- Transfer during food preparation at home or by handling in the market

Resistance to antibiotics

- Microbiological definition

Bacteria that possess a mechanism conferring them a Minimum (antimicrobial) Inhibitory Concentration (MIC) greater than the wild strain

Resistance to antibiotics

Survive in the presence of higher concentrations of an antimicrobial agent than the members of the parental population from which it emerged.

Resistance to antibiotics

- The lowest concentration of an antibiotic which will inhibit the growth of a particular microbe
- The MIC is an inverse measure of sensitivity the lower the MIC value of the antibiotic the greater sensitivity of the bacterium
- The larger the zone diameter, the lower the MIC

Resistance to antibiotics

- Small farmers
- Low technical knowledge
- Open market
- Wide range of commercial products
- Quality guaranty
- Insufficient health support and diagnosis services

Resistance to antibiotics

- Under-regulation or insufficient enforcement
- Excessive and inappropriate use of antimicrobials

Resistance to antibiotics

- *Campylobacter sp.*, *Klebsiella pneumoniae, Salmonella sp.*, *Pseudomonas_aeruginosa*,
- *Aeromonas hydrophila*, *A. salmonicida, Edwardsiella tarda, E.icttaluri*, *Vibrio anguillarum, V. salmonicida, Pasteurella piscida* and *Yersinia ruckeri*

Bacterial adaptation

- Inhibitors of protein synthesis
  - tetracyclines; aminoglycosides; chloramphenicol; florfenicol; macrolides; spectinomycin; lincosamides.

Bacterial adaptation

- Inhibitors of DNA function
  - nalidixic acid; ofloxacin; metronidazole; rifampin; enrofloxacin; sarafloxacin

Bacterial adaptation

- Inhibitors of folic acid synthesis (folic acid is needed to make RNA and DNA for growth and multiplication, and bacteria must synthesize it)
  - sulphonamides; sulfasalazine; trimethoprim; co-trimoxazole.

Bacterial adaptation

- Inhibitors of bacterial cell wall synthesis
  - penicillins; aminopenicillins; cephalosporins; vancomycin.

Bacterial adaptation

- Adaptation of bacteria to fluctuating antibiotic environment
- Multipurpose or multiple mechanisms of survival
- Associated-resistance mechanisms

Bacterial adaptation

Particular resistance profiles without a direct use of the corresponding drugs by the farmer

Bacterial adaptation

- Multi-efflux pumps in *E.coli* (AcrAB efflux system) for TE, C, AM, NA

- Alteration in outer membrane proteins of OA-resistant mutant benefit to TE, C and some ß-lactams

Bacterial adaptation

- Intrinsic resistance:
  enzymes (ß –lactamase)
  impermeability of the membrane
  absence of the target in the cell
- Acquired resistance

Bacterial adaptation

- Mobile genetic elements encoding for resistance : plasmids , transposons, integrons
- New gene combination
- Important role in horizontal tranfer and spread of resistance

Bacterial adaptation

- Plasmids and integrons encoding for resistance to tetracycline, chloramphenicol, sulphonamide, trimethoprime and ß-lactamases have been reported in fish bacteria

Bacterial adaptation

- plasmid carrying the *qnr* gene, which confers resistance to quinolone was found in Gram-negative microorganisms

(*Klebsiella pneumoniae* and *Escherichia coli*)

Bacterial adaptation

- The alteration in outer membrane proteins of OA-resistant mutants could benefit to TE, C and some β-lactams

Bacterial adaptation

- the expression of an outer membrane protein (OMP54) in *Stenotrophomonas maltophila* was associated with an increase of the MIC for TE, C and quinolones, but not for β-lactams

Bacterial adaptation

- Associated-resistance has been reported for:
  - S-SXT in *Enterobacteriaceae*
  - OA-OTC in *Aeromonas salmonicida*
  - AM-OTC in Gram-negative bacteria from cultured catfish
  - OTC-SXT in *Aeromonas salmonicida*

Bacterial adaptation

In response to a fluctuating antibiotic environment bacteria optimises its resistance system towards multiple drugs to survive

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1- Oxytetracycline OTC

2- Chloramphenicol C

3- Trimethoprim-Sulphamethoxazol SXT

4- Nitrofurantoin FT

5- Nalidixic acid NA

6- Ampicillin AM

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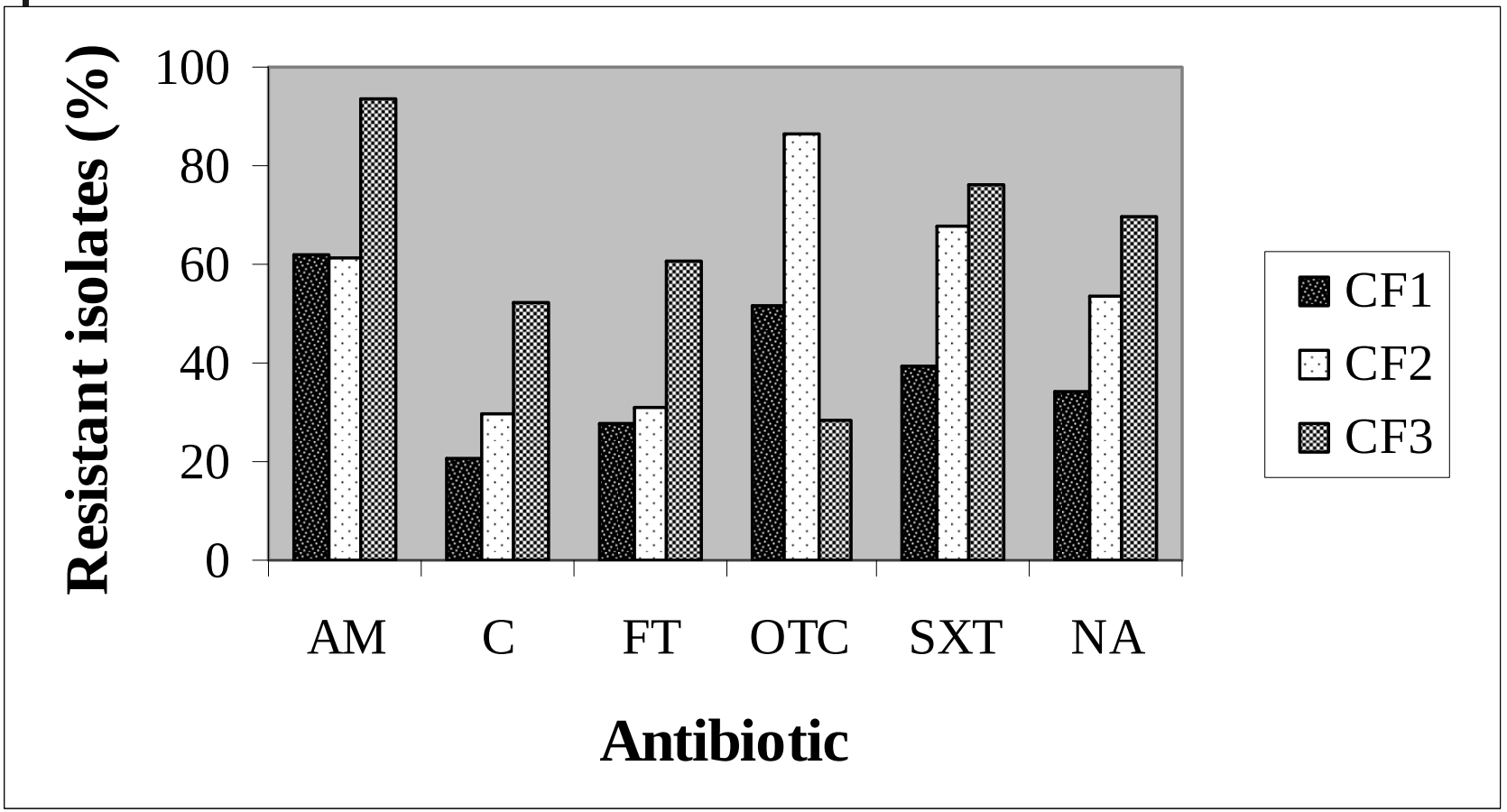

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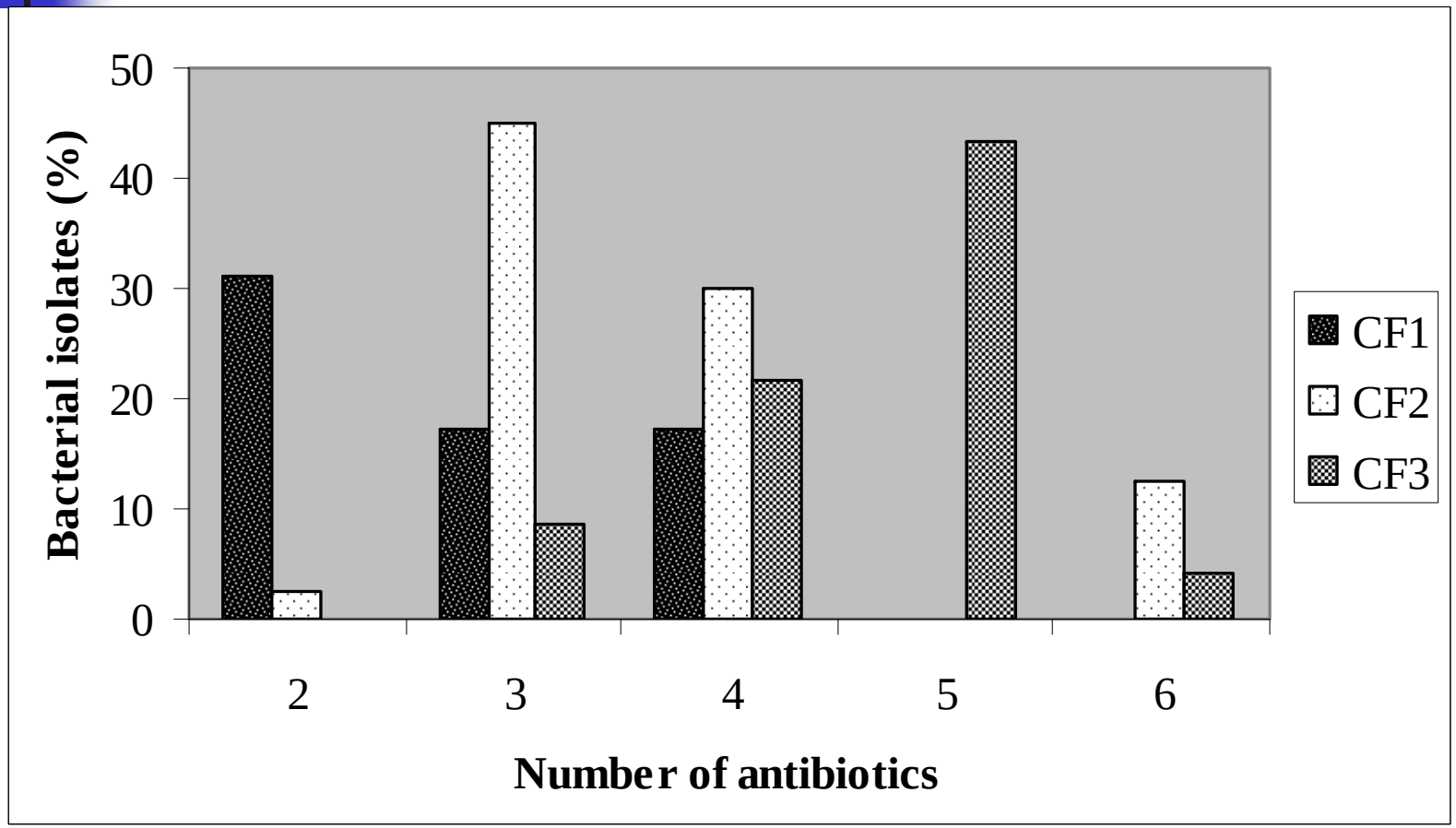


Better Management Practices

- Health management practices
- Optimal environment
- Bacterial infections
  - Animal health
  - Economic losses
- Antibiotic cover (responsibly)

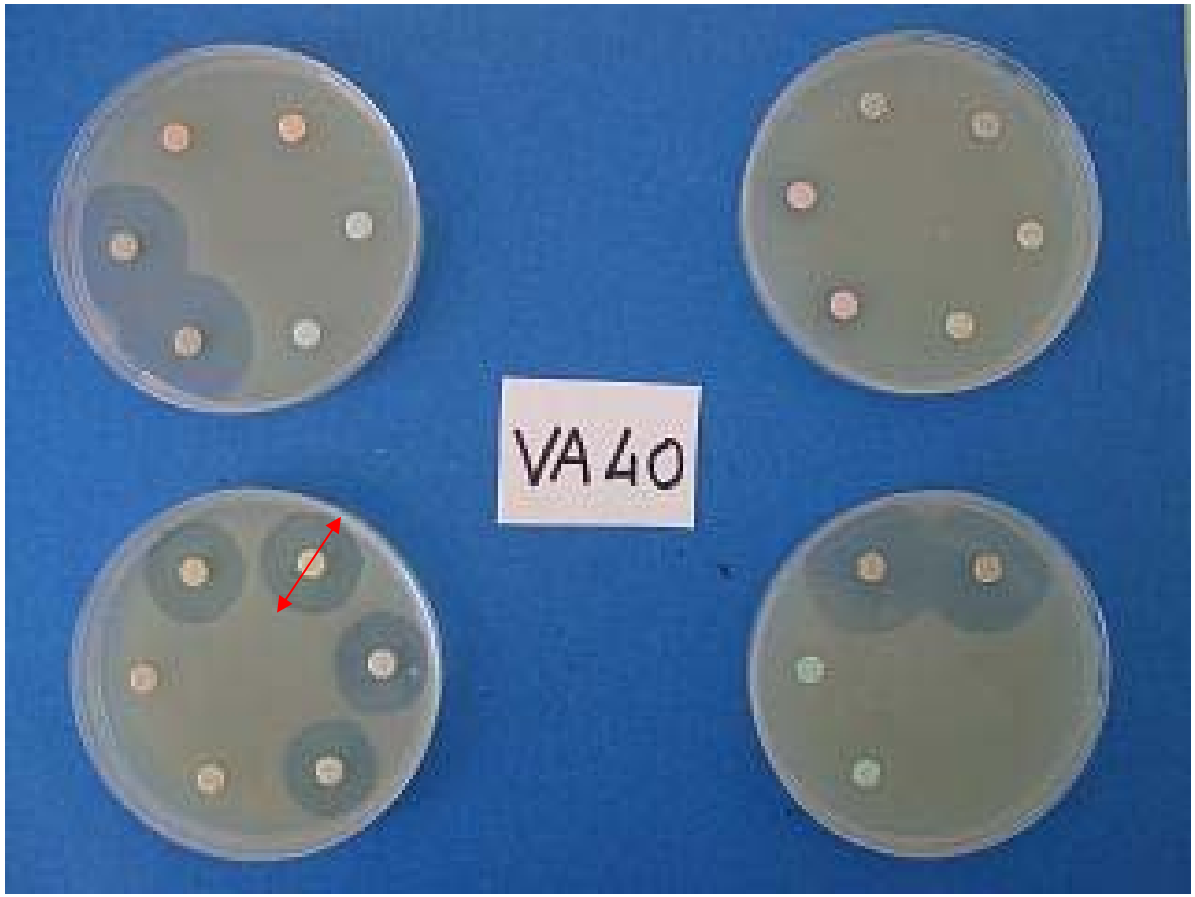
Better Management Practices

- Drug resistance monitoring
  - Optimal use
  - Better management
- Evaluation of the benefits and risks
  - Collecting detailed information about their use in aquaculture

Better Management Practices

- For routine susceptibility testing
  - Disc diffusion technique
    qualitative or semi-quantitative
  - Liquid medium dilution technique
    quantitative

Better Management Practices



Sensible
Résistante
Intermédiaire

Better Management Practices

- Liquid medium dilution technique:
  - Expensive and time consuming test
  - Only done when a few organisms must be tested or when accurate MIC estimation is needed

Better Management Practices

- Significant component of production costs
- Economic reason driving the search for alternative disease control strategies
- The larger and more sophisticated fish farming

Research perspectives

- Better understanding and control of antimicrobial resistance
- Research for alternatives

Research perspectives

- Evaluation of antimicrobial peptide in fish farming in France (Ifremer-Cirad project funded by the ANR 2006-07)
  - penaeidin
  - broad activity spectrum
  - *Dicentrachus labrax*

Research perspectives

- Evaluation of essential oils in shrimp farming in Madagascar (collaboration with URP Forest and Biodiversity funded by the French cooperation 2004-07)
  - endemic plant
  - chemical composition
  - antimicrobial activity
  - *Penaeus monodon*